APPENDIX G
WEATHER AND TERRAIN EFFECTS

Environmental factors and terrain affect smoke cloud behavior. Steering winds, temperature gradients and the type of terrain are important for accurately predicting smoke cloud travel. See FM 3-6, *Field Behavior of NBC Agents (Including Smoke),* for more detailed information.

WEATHER

Meteorological conditions that have the most effect on smoke screening and munitions expenditures (including the deployment smoke generators) include wind, temperature gradients, humidity, precipitation, and cloud cover.

WIND

The weather condition with the greatest impact on smoke operations is wind. Both wind direction and wind speed play a significant role in almost everything that deals with smoke operations. These factors are important in estimating equipment, munitions, and fog oil requirements for a smoke operation.

Wind direction determines where smoke must be released and where it will travel. There are four different types of wind directions that affect smoke operations: head winds, tail winds, flanking winds, and quartering winds. Favorable wind directions in relation to the smoke objective are the tail, quartering, and flanking winds.

Head winds are those blowing from the smoke objective directly toward the smoke source and are unfavorable for smoke generator operations.

Tail winds, the most favorable for smoke operations, blow toward the smoke objective from behind the smoke source.

Flanking winds blow directly across the smoke objective and the smoke source and are generally favorable for smoke operations.

Quartering winds blow between the other winds toward the smoke objective.

It is important to make the distinction between those surface wind directions just discussed and steering winds. Steering winds occur between 6 meters and 200 meters above the earth's surface. They are the winds that actually carry the smoke and determine the direction of smoke travel.

Wind speed has as much influence on smoke behavior as wind direction has. Low wind speed or calm conditions allow smoke to remain in the target area for a longer period of time. In addition, some types of smoke behave differently at different wind speeds. For example, white phosphorus (WP) tends to pillar if winds are less than 9 knots (17 kilometers per hour). HC smoke rises when the wind speed is less than 4 knots (7 kilometers per hour), and it is torn apart by wind speeds over 13 knots (24 kilometers per hour). Smoke from mechanical smoke generators may be effective in higher wind speeds because of the great volume produced.

TEMPERATURE GRADIENTS

Temperature, by itself, has no direct relationship with making effective smoke. It does, however, have an indirect relationship, which is a result of temperature gradients. Temperature gradients are difficult to obtain and such information is not normally available. However, it is imperative to try and get representative data. This can be possibly obtained from a nearby airport or other source of weather data. Temperature gradients are determined by comparing the air temperature at 0.5 meter above the ground with the air temperature at 4 meters. Three types of temperature gradients influence smoke: unstable (lapse), neutral, and stable (inversion).

Unstable

An unstable (lapse) condition exists when air temperature decreases with an increase in altitude. This condition is characterized by vertical air currents and turbulence. Thus, smoke tends to break up and become diffused. Lapse conditions are best for producing smoke curtains.

Neutral

A neutral condition exists when air temperature shows very little or no change with an increase in altitude. Neutral conditions also exist when the wind speed is greater than 9 kilometers per hour. Under this condition, vertical air currents are very limited. Neutral conditions are best for smoke hazes and smoke blankets; however, this is not the most favorable temperature gradient for smoke.

Stable

A stable (inversion) condition exists when the air temperature increases with an increase in altitude. This condition greatly limits vertical air currents. A smoke cloud produced during inversion conditions lies low to the ground and may reduce visibility at ground level. Inversion conditions are excellent for smoke hazes and smoke blankets but only if there is enough wind to carry the smoke over the target area.

HUMIDITY

Practically all smoke particles absorb moisture from the air. Moisture increases particle size and density and makes the smoke more effective. Most smoke munitions produce a denser (thicker) smoke when the humidity is high than when it is low; therefore, high humidity is generally favorable for smoke employment. Humidity has no effect on fog oil smoke.

PRECIPITATION

Since light rains decrease visibility, less smoke gives concealment during these rains. Heavy rains and snow reduce visibility; therefore, smoke is rarely needed for concealment during those conditions. When used during periods of precipitation, smoke tends to remain close to the ground and spread out over a large area. When used during periods of falling or blowing snow, the snow crystals will remove smoke from the air, reducing obscuration effectiveness.

CLOUD COVER

The amount of clouds in the sky gives an indication of how smoke will act on the battlefield. The general rule is when the sky is covered with clouds, the atmosphere is relatively stable and the conditions are generally favorable for making smoke.

TERRAIN EFFECTS

Since smoke is carried by the wind, it usually follows the contours of the earth's surface. Therefore, the type of terrain over which the smoke travels has a tremendous impact on how effective the smoke coverage will be in a specified area. Smoke will act differently over the different types of terrain.

FLAT, UNBROKEN TERRAIN AND OVER WATER

On flat, unbroken terrain, and over water, the individual smoke streamers take longer to spread out and mix with other streamers. Therefore, the uniform phase will usually develop a greater distance downwind.

OBSTRUCTIONS

Obstructions, such as trees and small buildings, tend to break up smoke streamers. These streamers re-form, cover a much larger area, and eventually create a more uniform cloud. This uniform cloud develops much quicker and closer to the smoke source than if the terrain were open. A wooded area that contains an abundance of obstructions is the most favorable type of terrain for smoke generator operations.

LARGE HILL MASSES AND MOUNTAINS

Steep hills and mountains tend to split winds. The winds eddy around the hills and mountains as well as over them. Large hill masses and rugged terrain cause strong cross currents. These currents disperse smoke excessively and create holes and unevenness in the smoke screen. In addition, thermally induced slope winds occur throughout the day and night. These conditions make it extremely difficult to establish and maintain a smoke screen. Wind currents, eddies, and turbulence in mountainous terrain must be continuously studied and observed.

SLOPES AND VALLEYS

In areas where there are valleys and other types of slopes, the climatic conditions are usually different at different times of the day. These areas are characterized by thermally induced slope winds that occur throughout the day and night. During the daytime, the heating effect causes these winds to blow up the slope, and they are referred to as up-slope winds. At night, the cooling effect causes the winds to blow down the slopes, and they are called down-slope winds. This is a very general rule; however, it is one that needs to be kept in mind when planning smoke operations.